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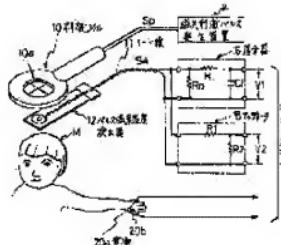
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(54) MAGNETIC STIMULUS DETECTING DEVICE

(57)Abstract:

PURPOSE: To accurately measure the magnetic flux density and field intensity of magnetic stimulus pulses to a stimulated portion with a simple structure having no power source when applying a magnetic stimulus.

CONSTITUTION: Pulses S_p are sent to a stimulating coil 10 from a magnetic stimulus pulse generator 14. The stimulating coil 10 generates the magnetic flux based on the inputted pulses S_p and gives a magnetic stimulus to the cerebrum of testee M. This magnetic flux is detected by a one-turn magnetic flux detecting coil in a pulse magnetic flux density detector 12 arranged in close contact with the stimulating coil 10, and the induced voltage is generated by the detected magnetic flux. The induced voltage, i.e., detection signal S_a , is guided through lead wires 11 twisted with two insulated wires to reduce the parasitic opening area for the magnetic flux, and the integrated voltage V_1 and the divided voltage V_2 indicating the magnetic flux density and the field intensity of the magnetic stimulus pulses are obtained through an integrator 16 and an attenuator 18.



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CLAIMS

[Claim(s)]

[Claim 1]A thin insulating substrate characterized by comprising the following, and a coil which generates induced voltage when magnetic flux is detected.

One one turn magnetic detection coil arranged on one field of the above-mentioned insulating substrate.

A lead which twists two insulated wires, is connected to both ends of the doubling above-mentioned one turn magnetic detection coil one [at a time], and derives the above-mentioned induced voltage.

[Claim 2]A magnetic stimulation sensing device provided with a graduation which shows length from the center of a one turn magnetic detection coil on an insulating substrate in addition to the composition according to claim 1.

[Claim 3]A magnetic stimulation sensing device comprising:

A thin insulating substrate.

One one turn magnetic detection coil arranged on one field of the above-mentioned insulating substrate.

A lead which twists two insulated wires, is connected to both ends of the doubling above-mentioned one turn magnetic detection coil one [at a time], and derives the above-mentioned induced voltage.

One or more breakthroughs which have been arranged in the above-mentioned one turn magnetic detection coil, and penetrated the above-mentioned insulating substrate.

[Claim 4]A magnetic stimulation sensing device comprising:

A thin insulating substrate.

Two or more leads which twisted two insulated wires connected to each both ends one [at a time] so that each induced voltage of one one turn magnetic detection coil arranged at an end on one field of the above-mentioned insulating substrate and two or more above-mentioned one turn magnetic detection coils might be derived.

[Claim 5]It replaces with the one turn magnetic detection coil according to claim 1, 2, 3, or 4, A one turn magnetic detection coil is provided in both sides of an insulating substrate on the same mind, respectively, Connect an end part of one one turn magnetic detection coil, and an end part of a one turn magnetic detection coil of another side with a path cord so that it may become the same direction of a volume, and a two turn magnetic detection coil is formed, And the magnetic stimulation sensing device according to claim 1, 2, 3, or 4 connecting a lead which twisted two insulated wires for deriving induced voltage to both ends of this two turn magnetic detection coil.

[Claim 6]The magnetic stimulation sensing device according to claim 1, 2, 3, 4, or 5, wherein a breakthrough for directing the center of a coil to an insulating substrate of a center section of the one turn magnetic detection coil is provided.

[Claim 7]A magnetic stimulation sensing device provided with an integrating means which

outputs integrated voltage which operates with a non-power supply which consists of a resistor and a capacitor in addition to the composition according to claim 1, 2, 3, 4, 5, or 6, carries out time quadrature of the induced voltage drawn from a lead, and shows magnetic flux density.

[Claim 8] A magnetic stimulation sensing device provided with a voltage dividing means which outputs partial pressure voltage which in addition to the composition according to claim 1, 2, 3, 4, 5, 6, or 7 comprises a resistor, operates with a non-power supply, carries out the partial pressure of the induced voltage drawn from a lead, and shows field intensity.

[Claim 9] In addition to the composition according to claim 7 or 8, multiple connection is carried out to an input edge in an integrating means or a voltage dividing means to which two leads which derive induced voltage are connected. And a magnetic stimulation sensing device connecting a resistor for shunts of resistance with it from internal resistance of a coil to which two above-mentioned leads are connected. [large and resistance and] [smaller than a resistor in an integrating means]

[Claim 10] A magnetic stimulation sensing device, wherein the one turn magnetic detection coil according to claim 1 to 6 is formed by etching of copper foil on the above-mentioned insulating substrate.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]**[0001]**

[Industrial Application]This invention is used for a brain evoked potential inspection etc., and relates to the magnetic stimulation sensing device for measuring the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus in the subject at the time of performing magnetic stimulation.

[0002]

[Description of the Prior Art]Conventionally, this kind of magnetic stimulation device has detected the electrical change which carries out magnetic stimulation of the cerebrum and cancellation nerve of the subject by non-invasion, and is induced by this magnetic stimulation. This detected electrical change was observed with the monitor scope etc., and the effective information on clinical has been acquired from that measurement result.

[0003]This magnetic stimulation device is provided with the stimulus coil which carries out magnetic stimulation of the cerebrum and cancellation nerve of the subject by non-invasion, and the magnetic stimulation pulse generator to which a stimulus coil is connected.

[0004]When detecting the electrical change induced with a living body using the magnetic stimulation device of this composition, the pulse of 100 to 300 microseconds of width and the voltage 500V~800V is impressed to a stimulus coil from a magnetic stimulation pulse generator, for example. By the magnetic flux generated from a stimulus coil in this impression, an eddy current occurs in the conductive substance which is an inside of a living body. This eddy current stimulates a nerve and conducts to a living body's every direction. For example, when magnetic stimulation of the cerebrum is carried out, the evoked potential transmitted to the ulnar nerve or nervus medianus of a palm is detected through an electrode, and it is observing with the monitor scope etc.

[0005]

[Problem(s) to be Solved by the Invention]In the above magnetic stimulation devices of the conventional example, in order to conduct exact measurement and analysis, the magnetic flux amount to the site of the stimulus of the subject was measured. While the magnetic flux density from a stimulus coil to a site of the stimulus is high and the stimulation strength is strong, when there is much the number of times of a stimulus, damage to a site of the stimulus can be considered, and the report of damage to the site of the stimulus in an animal experiment is made. Therefore, in order to perform magnetic stimulation safely, it is necessary to measure the intensity of magnetic stimulation exactly but, and under the present circumstances, measurement in particular about the intensity of the magnetic stimulation of a measured region actual only by monitoring the output voltage of a stimulus coil from a magnetic stimulation device is not performed.

[0006]the time of this invention solving the fault in such a Prior art, and performing magnetic stimulation -- non-power supply **** -- the magnetic stimulation sensing device which can measure exactly the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus of the subject by simple composition is aimed at offer.

[0007]

[Means for Solving the Problem] To achieve the above objects, a magnetic stimulation sensing device of this invention, A thin insulating substrate and one one turn magnetic detection coil which are coils which generate induced voltage when magnetic flux is detected, and has been arranged on one field of the above-mentioned insulating substrate, It is composition provided with a lead which twists two insulated wires, is connected to both ends of the above-mentioned one turn magnetic detection coil one [at a time], and derives the above-mentioned induced voltage.

[0008] In addition to this composition, it has composition provided with a graduation which shows length from one turn magnetic detection coil to a longitudinal direction of a long insulating substrate.

[0009] One one turn magnetic detection coil in which a magnetic stimulation sensing device of this invention has been arranged on one field of the above-mentioned insulating substrate, It is arranged in a lead which twists two insulated wires, is connected to both ends of the doubling above-mentioned one turn magnetic detection coil one [at a time], and derives the above-mentioned induced voltage, and the above-mentioned one turn magnetic detection coil, and has composition provided with one or more breakthroughs which penetrated the above-mentioned insulating substrate.

[0010] An insulating substrate with a thin magnetic stimulation sensing device of this invention and one one turn magnetic detection coil arranged at an end on one field of the above-mentioned insulating substrate, It is composition provided with two or more leads which twisted two insulated wires connected to each both ends one [at a time] so that each induced voltage of two or more above-mentioned one turn magnetic detection coils might be derived.

[0011] Replace with each one turn magnetic detection coil, and a one turn magnetic detection coil is provided in both sides of an insulating substrate on the same mind, respectively, Connect an end part of one one turn magnetic detection coil, and an end part of a one turn magnetic detection coil of another side with a path cord so that it may become the same direction of a volume, and a two turn magnetic detection coil is formed, And it has composition which connects a lead which twisted two insulated wires for deriving induced voltage to both ends of this two turn magnetic detection coil.

[0012] It is the composition that a breakthrough for judging a part of subject at the time of giving magnetic flux from a stimulus coil at subject to an insulating substrate of a center section of the one turn magnetic detection coil is provided.

[0013] When operating with a non-power supply which consists of a resistor and a capacitor in addition to these composition and impressing pulse voltage to a stimulus coil, it is composition provided with an integrating means which outputs integrated voltage which carries out time quadrature of the pulse form induced voltage drawn from a lead, and shows magnetic flux density.

[0014] In addition to these composition, it comprises a resistor, operates with a non-power supply, and has composition provided with a voltage dividing means which outputs partial pressure voltage which carries out the partial pressure of the induced voltage drawn from a lead, and shows field intensity.

[0015] In addition to these composition, multiple connection is carried out to an input edge in an integrating means or a voltage dividing means to which two leads which derive induced voltage are connected, And it has composition which connects a resistor for shunts of resistance larger resistance than internal resistance of a coil to which two leads are connected and smaller than a resistor in an integrating means.

[0016] A magnetic detection coil has composition currently formed by etching of copper foil on the above-mentioned insulating substrate.

[0017]

[Function] By such composition, the magnetic stimulation sensing device of this invention generates the induced voltage from which the one turn magnetic detection coil arranged to the thin insulating substrate detected the pulse magnetic flux from a stimulus coil. This generated voltage is drawn through the twisted lead. That is, the parasitism effective area product to magnetic flux is reduced with the twisted lead, and the voltage induced only with the one turn

magnetic detection coil is drawn.

[0018]With the graduation of an insulating substrate, the interval of a stimulus coil and a one turn magnetic detection coil becomes clear. Also when a check is not only possible, but it tries to look in at a measured region and magnetic stimulation is performed in a volume conductor (for example, underwater) etc. by the breakthrough furthermore provided in the insulating substrate, a suitable stimulus is attained without checking generating of an eddy current. Through two or more one turn magnetic detection coils arranged to straight line shape at the longitudinal direction of an insulating substrate, detection of magnetic stimulation is performed and the magnetic stimulation of the wide range part in a test subject is detected from a stimulus coil.

[0019]Furthermore by the breakthrough of the insulating substrate of the center section of the one turn magnetic detection coil, the part of the subject at the time of giving magnetic flux to the subject becomes clear. High induced voltage occurs with the two turn magnetic detection coil which carried out the series connection of the coil provided in both sides of the insulating substrate. The partial pressure voltage which shows the integrated voltage which furthermore shows magnetic flux density, and field intensity has been obtained with the non-power supply. By the resistor for shunts formed in the input edge of the integrating means or voltage dividing means which is an outgoing end of a lead, the floating capacitance between stimulus coils decreases, combination by floating capacitance is prevented, and the noise in integrated voltage and partial pressure voltage is reduced.

[0020]thus, the time of performing magnetic stimulation -- non-power supply **** -- exact measurement with the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus of the subject is attained by simple composition.

[0021]

[Example]Next, the example of the magnetic stimulation sensing device of this invention is described in detail with reference to drawings. Drawing 1 is a lineblock diagram showing the 1st whole example. In drawing 1, while this magnetic stimulation sensing device is arranged in contact with the upper part of the head of the subject M, For example, the stimulus coil 10 which the pulse Sp of 100 to 300 microseconds of width and the voltage 500V-1000V is inputted, generates magnetic flux, and gives magnetic stimulation to the cerebrum of the subject M. It is arranged between the stimulus coil 10 and the magnetic stimulation part of the subject M, and has the pulse magnetic flux density detector 12 which derives the detecting signal Sa which is the voltage induced by the magnetic flux generated with the stimulus coil 10 through the lead 11 which twisted two insulated wires. The stimulus coil 10 consists of a circular coil part and a handle part, and the cross-joint wire 10a which intersected perpendicularly since the center point of this opening was specified is formed in the opening of a coil.

[0022]The magnetic stimulation pulse generator 14 in which this magnetic stimulation sensing device sends out the pulse Sp of 100 to 300 microseconds of width, and the voltage 500V-1000V to the stimulus coil 10, Time quadrature of the pulse form detecting signal Sa is carried out, and it has the integrator 16 outputted to the monitor scope etc. which do not illustrate the integrated voltage V1 which shows magnetic flux density. The attenuator 18 outputted to the monitor scope etc. which do not illustrate the partial pressure voltage V2 which carried out the partial pressure of the pulse form detecting signal Sa, the cerebrum of the subject M can be set to the ulnar nerve or nervus medianus of a palm at the time of carrying out magnetic stimulation with the stimulus coil 10 -- evoked potential detection being carried out and, It has the electrodes 20a and 20b for sending out to the evoked potential test equipment which inspects idiomatic AEP (auditory evoked potential), SEP (somatic evoked potential), VEP (visual evoked response), etc.

[0023]While the resistor Ro which the detecting signal Sa which led the lead 11 from the pulse magnetic flux density detector 12 is impressed in parallel, and carries out the shunt of the outgoing end of the pulse magnetic flux density detector 12 is built in, the integrator 16. It has the resistor Ri which outputs the integrated voltage V1 which integrated with the detecting signal Sa, and the capacitor Ci.

[0024]The attenuator 18 has the resistor R1 which outputs the partial pressure voltage V2 which carried out the partial pressure of the detecting signal Sa supplied through the lead 11 from the

pulse magnetic flux density detector 12, and R2.

[0025]Next, the pulse magnetic flux density detector 12 is explained in detail. Drawing 2 is a plan showing the detailed composition of the pulse magnetic flux density detector 12 in drawing 1. In drawing 2, this pulse magnetic flux density detector 12. The one turn magnetic detection coil 12b which generates the induced voltage which detected the magnetic flux which carried out the etching process of the copper foil to the substrates 12a, such as glass epoxy material, formed width in abbreviated 200-micrometer, and was generated with the stimulus coil 10. It is provided in the substrate 12a in the center in the one turn magnetic detection coil 12b, and has the breakthrough 12c for specifying the position of the measured region of the subject.

[0026]While this pulse magnetic flux density detector 12 is connected to the both ends of the one turn magnetic detection coil 12b, It is fixed on the substrate 12a and the parasitism effective area product to the magnetic flux from the stimulus coil 10 decreases, and in order to prevent the magnetic flux detection of those other than one turn magnetic detection coil 12b, it has the lead 12d which twisted two insulated wires. It is formed in the longitudinal direction of the lower end in the figure of the substrate 12a by printing etc.. The scale 12e for getting to know the distance estranged, the position 12b, i.e., the one turn magnetic detection coil, from the breakthrough 12c at the time of moving the stimulus coil 10 on the pulse magnetic flux density detector 12. In order to hold the fixed state of the lead 11 in drawing 1 and the connected lead 12d, it has the electrode holder 12f covered with integral moulding or a vinyl cap by resin, etc.

[0027]Drawing 3 is a plan showing the connected state of the one turn magnetic detection coil 12b in the pulse magnetic flux density detector 12 shown in drawing 2, and the lead 12d. To the land 30 which this example was provided in one field of the substrate 12a, and was formed in the end of the one turn magnetic detection coil 12b. It is arranged in a field opposite to the substrates face where this one turn magnetic detection coil 12b has been arranged, and the insulated wire 32 is connected with soldering etc. in the lead 12d which inserted in the breakthrough 31 and was pulled out.

[0028]The land 33a with a breakthrough is arranged and it is connected to the other end of the right-hand side in the figure of the one turn magnetic detection coil 12b in the land 33b and through hole which were established in the opposite substrates face of this land 33a.

Furthermore the land 33b has the soldering part 34, and the tip lead of the insulated wire 36 of another side in the lead 12d is connected to this soldering part 34 with soldering etc. The connection section of the one turn magnetic detection coil 12b and the lead 12d becomes stably and certain with this composition.

[0029]Next, the operation and the function in composition of this 1st example are explained. In drawing 1, the pulse Sp is sent out to the stimulus coil 10 from the magnetic stimulation pulse generator 14. The stimulus coil 10 generates the magnetic flux based on the pulse Sp inputted, and gives magnetic stimulation to the cerebrum of the subject M. This magnetic flux is detected with the one turn magnetic detection coil 12b in the pulse magnetic flux density detector 12 arranged by sticking to the stimulus coil 10. That is, the induced voltage which detected magnetic flux is generated. The detecting signal Sa which is this induced voltage is drawn through the lead 11.

[0030]Thus, the pulse magnetic flux density detector 12 is stuck to the stimulus coil 10, and when detecting the magnetic flux which the stimulus coil 10 generates, the measured region of the subject M can be easily coincided through the breakthrough 12c in the one turn magnetic detection coil 12b. By coinciding the intersection of the cross-joint wire 10a of the stimulus coil 10, and the breakthrough 12c in the one turn magnetic detection coil 12b, the stimulus coil 10 can always be arranged in a fixed position for every measurement to the one turn magnetic detection coil 12b. When estranging the stimulus coil 10 from the one turn magnetic detection coil 12b furthermore and measuring by performing magnetic stimulation, The distance of the stimulus coil 10 estranged from the center position of the one turn magnetic detection coil 12b becomes clear easily by reading the intersection of the cross-joint wire 10a in the stimulus coil 10 with the graduation of the scale 12e.

[0031]The lead 11 connected to the one turn magnetic detection coil 12b twists two insulated wires, and reduces the parasitism effective area product to magnetic flux by this. That is, the

voltage induced only with the one turn magnetic detection coil 12b is drawn, and a detection error is reduced. Parallel impression of the detecting signal Sa drawn through this lead 11 is carried out at the resistor Ro. This resistor Ro carries out the shunt of the outgoing end of the pulse magnetic flux density detector 12, and the floating capacitance between the stimulus coil 10 and the one turn magnetic detection coil 12b is reduced. A noise stops mixing in the integrated voltage V1 and the partial pressure voltage V2, without overlapping the pulse Sp etc. by which the stimulus coil 10 and the one turn magnetic detection coil 12b stop joining together with floating capacitance, and are impressed to the stimulus coil 10 by this. therefore, S/N at the time of observing the integrated voltage V1 and the partial pressure voltage V2 with a monitor scope (a signal/noise) — a ratio improves and more exact measurement is attained. The value of the resistor Ro in this case is set as larger resistance than the conductor resistance value of the one turn magnetic detection coil 12b, and resistance smaller than the resistor Ri in the integrator 16.

[0032]The pulse form detecting signal Sa is inputted into the integrator 16 through this resistor Ro, and the integrator 16 outputs the integrated voltage V1 for observing with the monitor scope which does not illustrate the magnetic flux density B which carried out time quadrature of the detecting signal Sa to the resistor Ri with the value of the capacitor Ci. The density of the magnetic flux which the stimulus coil 10 to which the pulse Sp is impressed generates is three-dimensional distribution which has maximum magnetic flux density in a hysteresis loop near an inside diameter. It will be equalized if this magnetic flux is detected with the one turn magnetic detection coil 12b of the limited effective area product in the pulse magnetic flux density detector 12. In this case, total of the magnetic flux density which pierces through the effective area product of the one turn magnetic detection coil 12b in flux density distribution is calculated, division of this is done by the effective area product of the one turn magnetic detection coil 12b, and it is considered as the magnetic flux density measured in the center position on which the one turn magnetic detection coil 12b was put.

[0033]The voltage e induced when the magnetic flux density B interlinks to the one turn magnetic detection coil 12b of the effective area product S is expressed with a following formula (1).

$$e = -d(B-S)/dt \quad (1)$$

[0034]The magnetic flux density B which carried out time quadrature of this voltage e is expressed with a following formula (2).

[Equation 1]

$$B = - (1/S) \int e dt$$

[0035]When this time quadrature is performed by damping time constant Ci-Ri (the resistor Ri and the capacitor Ci in the integrator 16 in drawing 1), the integrated voltage V1 which is an output of the integrator 16 can be expressed with a following formula (3).

[Equation 2]

$$V1 \propto (1/Ci \cdot Ri) \int e dt$$

[0036]The magnetic flux density B is expressed with a following formula (4) by the integrated voltage V1 from a formula (2) and a formula (3).

[Equation 3]

$$B \propto - (Ci \cdot Ri / S) V1$$

[0037]The integrated voltage V1 is observed and measured with the monitor scope which is not illustrated. For example, the time-axis of a monitor scope is made into 0.5 second/Div, and it processes by delay of 2D iv. Sensitivity is set as 5 mv/Div from 500microv/Div, and 0.05 Hz -10 kHz are suitable for a filter.

[0038]The attenuator 18 carries out the partial pressure of the detecting signal Sa supplied through the lead 11 from the pulse magnetic flux density detector 12 by the resistor R1 and R2, and observes it with the monitor scope which does not illustrate the partial pressure voltage V2. This is for knowing change of this magnetic flux phi in order for an eddy current to occur in the conductive substance which is an inside of a living body by the magnetic flux phi generated from

the stimulus coil 10, and for this eddy current to stimulate a nerve and to conduct it to a living body's every direction.

[0039] This partial pressure voltage V2 is expressed with a following formula (5).

$$V2 = k (d \phi / dt) \quad (5)$$

[0040] This partial pressure voltage V2 as well as the integrated voltage V1 is observed with a monitor scope. Thus, the amount of magnetic stimulation from the integrated voltage V1 to the cerebrum of the subject M will become clear. Change of the magnetic flux from the partial pressure voltage V2 to the cerebrum of the subject M also becomes clear.

[0041] The evoked potential in the ulnar nerve or nervus medianus of a palm at the time of carrying out magnetic stimulation of the cerebrum of the subject M with the stimulus coil 10 is detected by the electrodes 20a and 20b. The evoked potential by the magnetic stimulation from these electrodes 20a and 20b is measured with idiomatic evoked potential test equipment. This measurement is the same inspection method as well-known AEP (auditory evoked potential), SEP (somatic evoked potential), VEP (visual evoked response), etc.

[0042] Next, the 2nd example is described. Drawing 4 is a plan showing the composition of the pulse magnetic flux density detector in the 2nd example. In drawing 4, this pulse magnetic flux density detector 40, The one turn magnetic detection coil 40b which detects the magnetic flux which carried out the etching process of the copper foil to the substrates 40a, such as glass epoxy material, formed it in them, and was generated with the stimulus coil 10, It is provided in the substrate 40a of the center in the one turn magnetic detection coil 40b, and has the breakthrough 40c for specifying the position of the measured region of the subject.

[0043] In order to form this pulse magnetic flux density detector 40 in the inside of the one turn magnetic detection coil 40b, and the circumference of the breakthrough 40c and to try to look in at the measured region of the subject, Or the four windows 41a, 41b, 41c, and 41d for a suitable stimulus to be attained without checking generating of an eddy current when magnetic stimulation is performed in a volume conductor etc., In order to be connected to the both ends of the one turn magnetic detection coil 40b, to reduce the parasitism effective area product to the magnetic flux from the stimulus coil 10 and to prevent the magnetic flux detection of those other than one turn magnetic detection coil 40b, It has the lead 42 which twisted two insulated wires, and the electrode holder 43 which covered the projecting site of the substrate 40a with integral moulding of resin, or a vinyl cap in order to hold the fixed state of the lead 42. It is in this composition and the connection between the both ends of the one turn magnetic detection coil 40b and the lead 42 is the same as that of the connection structure shown by drawing 3.

[0044] Although operation of this pulse magnetic flux density detector 40 is the same as that of the pulse magnetic flux density detector 12 shown in drawing 2, when it performs magnetic stimulation from the windows 41a-41d, it has seen the site of the stimulus of the subject. The part at the time of this performing magnetic stimulation, the conduction direction of the nerve to give magnetic flux, for example, etc. become clear correctly.

[0045] Furthermore, the 3rd example is described. Drawing 5 is a plan showing the composition of the pulse magnetic flux density detector 50 in the 3rd example. This pulse magnetic flux density detector 50 carries out the etching process of the copper foil to the oblong substrates 50a, such as glass epoxy material, and forms it in them, The four one turn magnetic detection coils 51a, 52a, 53a, and 54a which detected the magnetic flux generated with the stimulus coil 10, and have been arranged on a straight line, It is provided in the substrate 50a in each center section of the one turn magnetic detection coils 51a-54a, and has the breakthroughs 51b, 52b, 53b, and 54b for specifying the position of the measured region of the subject.

[0046] To this pulse magnetic flux density detector 50, In order to reduce the parasitism effective area product to the magnetic flux from the stimulus coil 10 connected to each both ends of the one turn magnetic detection coils 51a-54a and to prevent the magnetic flux detection of those other than the one turn magnetic detection coil 51a - 54a, It has the leads 51c, 52c, 53c, and 54c which twisted two insulated wires, and the electrode holder 55 which covered the projecting site of the substrate 50a with integral moulding of resin, or a vinyl cap in order to hold the fixed state of these leads 51c-54c. It is in this composition and each both ends of the one turn magnetic detection coils 51a-54a and the connection with the leads 51c-54c are the same as

that of the connection structure shown by drawing 3.

[0047] This pulse magnetic flux density detector 50 is the four one turn magnetic detection coils 51a-54a arranged on a straight line, and becomes measurable with one detector about four measured regions in the subject. For example, although magnetic stimulation of many parts will be carried out and they will be measured by the subject in the pulse magnetic flux density detector 40 shown in the pulse magnetic flux density detector 12 or drawing 4 shown in drawing 2, which has arranged one WATTAN magnetic detection coil, shifting the position, In this pulse magnetic flux density detector 50, since the magnetic flux density and field intensity of the magnetic stimulation pulse of four nearby parts can be measured at once, measuring time can be shortened.

[0048] Furthermore, the 4th example is described. drawing 6 is a plan showing the composition of the pulse magnetic flux density detector in the 4th example. In drawing 6, the two turn magnetic detection coil is used for this pulse magnetic flux density detector 60 to the case where the pulse magnetic flux density detectors 12, 40, and 50 use the one turn magnetic detection coil for detection of magnetic flux, respectively.

[0049] The one turn magnetic detection coils 63a and 63b which detect the magnetic flux which this example countered the identical parts of both sides of the substrates 62a, such as glass epoxy material, carried out the etching process of the copper foil, formed it, and was generated with the stimulus coil 10. It is provided in the substrate 62a of the center in these one turn magnetic detection coils 63a and 63b, and has the breakthrough 64 for specifying the position of the measured region of the subject.

[0050] This pulse magnetic flux density detector 60 has the terminal area which connected the lead 65 which connects spirally the one turn magnetic detection coils 63a and 63b, and forms a two turn magnetic detection coil, and twisted two insulated wires. The breakthrough 66 of quadrangular shape by which this terminal area was provided among the both ends of the one turn magnetic detection coils 63a and 63b, This breakthrough 66 is inserted in and it has the jumper line 67 for forming the two turn magnetic detection coil which connected one end of the right-hand side in the figure of the one turn magnetic detection coil 63a, and the other end of the left-hand side in the figure of the one turn magnetic detection coil 63b, and was connected spirally.

[0051] A left-hand side end and the tip lead of one insulated wire 65a of the lead 65 are connected, [in / in this terminal area / the figure of the one turn magnetic detection coil 63a] The tip lead of the insulated wire 65b of another side of the lead 65 is inserted in in the breakthrough 66, and is connected with the other end of the right-hand side in the figure of the one turn magnetic detection coil 63b.

[0052] This pulse magnetic flux density detector 60 connects the one turn magnetic detection coils 63a and 63b with the jumper line 67, and forms them in a two turn magnetic detection coil. And the induced voltage by the magnetism generated with the stimulus coil 10 is drawn as a detecting signal with this two turn magnetic detection coil. In this case, since high induced voltage is obtained, a S/N ratio improves and the magnetic flux density and field intensity of a high-precision magnetic stimulation pulse can be measured.

[0053] If constituted in the pulse magnetic flux density detectors 12, 40, and 50 with the application of the pulse magnetic flux density detector 60 of the two turn magnetic detection coil shown in this drawing 6, It combines with each advantage, high induced voltage is obtained, a S/N ratio improves more, and measurement with the magnetic flux density and field intensity of a still highly precise magnetic stimulation pulse is attained.

[0054]

[Effect of the Invention] A one turn magnetic detection coil generates the induced voltage which detected the pulse magnetic flux from a stimulus coil, and is drawing the magnetic stimulation sensing device of this invention through the twisted lead so that clearly from the above explanation. In this case, the part of magnetic stimulation becomes clear easily with a graduation, a breakthrough, and two or more one turn magnetic detection coils, and magnetic stimulation to two or more parts is performed easily. A suitable stimulus is attained without checking generating of an eddy current by the window furthermore provided inside the one turn magnetic

detection coil, even if it is a case where magnetic stimulation is performed in a volume conductor etc. While high induced voltage occurs with a two turn magnetic detection coil, the integrated voltage and partial pressure voltage which show the magnetic flux density and field intensity of a magnetic stimulation pulse have been obtained with the non-power supply. Floating capacitance decreases by the resistor further for shunts, and the noise in integrated voltage and partial pressure voltage is reduced.

[0055]the time of these performing magnetic stimulation -- non-power supply **** -- it has the effect that exact measurement with the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus of the subject is attained, with simple composition.

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TECHNICAL FIELD

[Industrial Application]This invention is used for a brain evoked potential inspection etc., and relates to the magnetic stimulation sensing device for measuring the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus in the subject at the time of performing magnetic stimulation.

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PRIOR ART

[Description of the Prior Art]Conventionally, this kind of magnetic stimulation device has detected the electrical change which carries out magnetic stimulation of the cerebrum and cancellation nerve of the subject by non-invasion, and is induced by this magnetic stimulation. This detected electrical change was observed with the monitor scope etc., and the effective information on clinical has been acquired from that measurement result.

[0003]This magnetic stimulation device is provided with the stimulus coil which carries out magnetic stimulation of the cerebrum and cancellation nerve of the subject by non-invasion, and the magnetic stimulation pulse generator to which a stimulus coil is connected.

[0004]When detecting the electrical change induced with a living body using the magnetic stimulation device of this composition, the pulse of 100 to 300 microseconds of width and the voltage 500V~800V is impressed to a stimulus coil from a magnetic stimulation pulse generator, for example. By the magnetic flux generated from a stimulus coil in this impression, an eddy current occurs in the conductive substance which is an inside of a living body. This eddy current stimulates a nerve and conducts to a living body's every direction. For example, when magnetic stimulation of the cerebrum is carried out, the evoked potential transmitted to the ulnar nerve or nervus medianus of a palm is detected through an electrode, and it is observing with the monitor scope etc.

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EFFECT OF THE INVENTION

[Effect of the Invention]A one turn magnetic detection coil generates the induced voltage which detected the pulse magnetic flux from a stimulus coil, and is drawing the magnetic stimulation sensing device of this invention through the twisted lead so that clearly from the above explanation. In this case, the part of magnetic stimulation becomes clear easily with a graduation, a breakthrough, and two or more one turn magnetic detection coils, and magnetic stimulation to two or more parts is performed easily. A suitable stimulus is attained without checking generating of an eddy current by the window furthermore provided inside the one turn magnetic detection coil, even if it is a case where magnetic stimulation is performed in a volume conductor etc. While high induced voltage occurs with a two turn magnetic detection coil, the integrated voltage and partial pressure voltage which show the magnetic flux density and field intensity of a magnetic stimulation pulse have been obtained with the non-power supply. Floating capacitance decreases by the resistor further for shunts, and the noise in integrated voltage and partial pressure voltage is reduced.

[0055]the time of these performing magnetic stimulation -- non-power supply **** -- it has the effect that exact measurement with the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus of the subject is attained, with simple composition.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]In the above magnetic stimulation devices of the conventional example, in order to conduct exact measurement and analysis, the magnetic flux amount to the site of the stimulus of the subject was measured. While the magnetic flux density from a stimulus coil to a site of the stimulus is high and the stimulation strength is strong, when there is much the number of times of a stimulus, damage to a site of the stimulus can be considered, and the report of damage to the site of the stimulus in an animal experiment is made. Therefore, in order to perform magnetic stimulation safely, it is necessary to measure the intensity of magnetic stimulation exactly but, and under the present circumstances, measurement in particular about the intensity of the magnetic stimulation of a measured region actual only by monitoring the output voltage of a stimulus coil from a magnetic stimulation device is not performed.

[0006]the time of this invention solving the fault in such a Prior art, and performing magnetic stimulation -- non-power supply **** -- the magnetic stimulation sensing device which can measure exactly the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus of the subject by simple composition is aimed at offer.

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MEANS

[Means for Solving the Problem]To achieve the above objects, a magnetic stimulation sensing device of this invention, A thin insulating substrate and one one turn magnetic detection coil which are coils which generate induced voltage when magnetic flux is detected, and has been arranged on one field of the above-mentioned insulating substrate, It is composition provided with a lead which twists two insulated wires, is connected to both ends of the above-mentioned one turn magnetic detection coil one [at a time], and derives the above-mentioned induced voltage.

[0008]In addition to this composition, it has composition provided with a graduation which shows length from a one turn magnetic detection coil to a longitudinal direction of a long insulating substrate.

[0009]One one turn magnetic detection coil in which a magnetic stimulation sensing device of this invention has been arranged on one field of the above-mentioned insulating substrate, It is arranged in a lead which twists two insulated wires, is connected to both ends of the doubling above-mentioned one turn magnetic detection coil one [at a time], and derives the above-mentioned induced voltage, and the above-mentioned one turn magnetic detection coil, and has composition provided with one or more breakthroughs which penetrated the above-mentioned insulating substrate.

[0010]An insulating substrate with a thin magnetic stimulation sensing device of this invention and one one turn magnetic detection coil arranged at an end on one field of the above-mentioned insulating substrate, It is composition provided with two or more leads which twisted two insulated wires connected to each both ends one [at a time] so that each induced voltage of two or more above-mentioned one turn magnetic detection coils might be derived.

[0011]Replace with each one turn magnetic detection coil, and a one turn magnetic detection coil is provided in both sides of an insulating substrate on the same mind, respectively, Connect an end part of one one turn magnetic detection coil, and an end part of a one turn magnetic detection coil of another side with a path cord so that it may become the same direction of a volume, and a two turn magnetic detection coil is formed, And it has composition which connects a lead which twisted two insulated wires for deriving induced voltage to both ends of this two turn magnetic detection coil.

[0012]It is the composition that a breakthrough for judging a part of subject at the time of giving magnetic flux from a stimulus coil at subject to an insulating substrate of a center section of the one turn magnetic detection coil is provided.

[0013]When operating with a non-power supply which consists of a resistor and a capacitor in addition to these composition and impressing pulse voltage to a stimulus coil, it is composition provided with an integrating means which outputs integrated voltage which carries out time quadrature of the pulse form induced voltage drawn from a lead, and shows magnetic flux density.

[0014]In addition to these composition, it comprises a resistor, operates with a non-power supply, and has composition provided with a voltage dividing means which outputs partial pressure voltage which carries out the partial pressure of the induced voltage drawn from a lead, and shows field intensity.

[0015]In addition to these composition, multiple connection is carried out to an input edge in an integrating means or a voltage dividing means to which two leads which derive induced voltage are connected, And it has composition which connects a resistor for shunts of resistance larger resistance than internal resistance of a coil to which two leads are connected and smaller than a resistor in an integrating means.

[0016]A magnetic detection coil has composition currently formed by etching of copper foil on the above-mentioned insulating substrate.

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OPERATION

[Function]By such composition, the magnetic stimulation sensing device of this invention generates the induced voltage from which the one turn magnetic detection coil arranged to the thin insulating substrate detected the pulse magnetic flux from a stimulus coil. This generated voltage is drawn through the twisted lead. That is, the parasitism effective area product to magnetic flux is reduced with the twisted lead, and the voltage induced only with the one turn magnetic detection coil is drawn.

[0018]With the graduation of an insulating substrate, the interval of a stimulus coil and a one turn magnetic detection coil becomes clear. Also when a check is not only possible, but it tries to look in at a measured region and magnetic stimulation is performed in a volume conductor (for example, underwater) etc. by the breakthrough furthermore provided in the insulating substrate, a suitable stimulus is attained without checking generating of an eddy current. Through two or more one turn magnetic detection coils arranged to straight line shape at the longitudinal direction of an insulating substrate, detection of magnetic stimulation is performed and the magnetic stimulation of the wide range part in a test subject is detected from a stimulus coil.

[0019]Furthermore by the breakthrough of the insulating substrate of the center section of the one turn magnetic detection coil, the part of the subject at the time of giving magnetic flux to the subject becomes clear. High induced voltage occurs with the two turn magnetic detection coil which carried out the series connection of the coil provided in both sides of the insulating substrate. The partial pressure voltage which shows the integrated voltage which furthermore shows magnetic flux density, and field intensity has been obtained with the non-power supply. By the resistor for shunts formed in the input edge of the integrating means or voltage dividing means which is an outgoing end of a lead, the floating capacitance between stimulus coils decreases, combination by floating capacitance is prevented, and the noise in integrated voltage and partial pressure voltage is reduced.

[0020]thus, the time of performing magnetic stimulation -- non-power supply **** -- exact measurement with the magnetic flux density and field intensity of the magnetic stimulation pulse over the site of the stimulus of the subject is attained by simple composition.

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EXAMPLE

[Example]Next, the example of the magnetic stimulation sensing device of this invention is described in detail with reference to drawings. Drawing 1 is a lineblock diagram showing the 1st whole example. In drawing 1, while this magnetic stimulation sensing device is arranged in contact with the upper part of the head of the subject M, For example, the stimulus coil 10 which the pulse Sp of 100 to 300 microseconds of width and the voltage 500V-1000V is inputted, generates magnetic flux, and gives magnetic stimulation to the cerebrum of the subject M. It is arranged between the stimulus coil 10 and the magnetic stimulation part of the subject M, and has the pulse magnetic flux density detector 12 which derives the detecting signal Sa which is the voltage induced by the magnetic flux generated with the stimulus coil 10 through the lead 11 which twisted two insulated wires. The stimulus coil 10 consists of a circular coil part and a handle part, and the cross-joint wire 10a which intersected perpendicularly since the center point of this opening was specified is formed in the opening of a coil.

[0022]The magnetic stimulation pulse generator 14 in which this magnetic stimulation sensing device sends out the pulse Sp of 100 to 300 microseconds of width, and the voltage 500V-1000V to the stimulus coil 10, Time quadrature of the pulse form detecting signal Sa is carried out, and it has the integrator 16 outputted to the monitor scope etc. which do not illustrate the integrated voltage V1 which shows magnetic flux density. The attenuator 18 outputted to the monitor scope etc. which do not illustrate the partial pressure voltage V2 which carried out the partial pressure of the pulse form detecting signal Sa, the cerebrum of the subject M can be set to the ulnar nerve or nervus medianus of a palm at the time of carrying out magnetic stimulation with the stimulus coil 10 — evoked potential detection being carried out and, It has the electrodes 20a and 20b for sending out to the evoked potential test equipment which inspects idiomatic AEP (auditory evoked potential), SEP (somatic evoked potential), VEP (visual evoked response), etc.

[0023]While the resistor Ro which the detecting signal Sa which led the lead 11 from the pulse magnetic flux density detector 12 is impressed in parallel, and carries out the shunt of the outgoing end of the pulse magnetic flux density detector 12 is built in, the integrator 16, It has the resistor Ri which outputs the integrated voltage V1 which integrated with the detecting signal Sa, and the capacitor Ci.

[0024]The attenuator 18 has the resistor R1 which outputs the partial pressure voltage V2 which carried out the partial pressure of the detecting signal Sa supplied through the lead 11 from the pulse magnetic flux density detector 12, and R2.

[0025]Next, the pulse magnetic flux density detector 12 is explained in detail. Drawing 2 is a plan showing the detailed composition of the pulse magnetic flux density detector 12 in drawing 1. In drawing 2, this pulse magnetic flux density detector 12, The one turn magnetic detection coil 12b which generates the induced voltage which detected the magnetic flux which carried out the etching process of the copper foil to the substrates 12a, such as glass epoxy material, formed width in abbreviated 200-micrometer, and was generated with the stimulus coil 10, It is provided in the substrate 12a in the center in the one turn magnetic detection coil 12b, and has the breakthrough 12c for specifying the position of the measured region of the subject.

[0026]While this pulse magnetic flux density detector 12 is connected to the both ends of the

one turn magnetic detection coil 12b, It is fixed on the substrate 12a and the parasitism effective area product to the magnetic flux from the stimulus coil 10 decreases, and in order to prevent the magnetic flux detection of those other than one turn magnetic detection coil 12b, it has the lead 12d which twisted two insulated wires. It is formed in the longitudinal direction of the lower end in the figure of the substrate 12a by printing etc.. The scale 12e for getting to know the distance estranged, the position 12b, i.e., the one turn magnetic detection coil, from the breakthrough 12c at the time of moving the stimulus coil 10 on the pulse magnetic flux density detector 12, In order to hold the fixed state of the lead 11 in drawing 1, and the connected lead 12d, it has the electrode holder 12f covered with integral moulding or a vinyl cap by resin, etc. [0027]Drawing 3 is a plan showing the connected state of the one turn magnetic detection coil 12b in the pulse magnetic flux density detector 12 shown in drawing 2, and the lead 12d. To the land 30 which this example was provided in one field of the substrate 12a, and was formed in the end of the one turn magnetic detection coil 12b. It is arranged in a field opposite to the substrates face where this one turn magnetic detection coil 12b has been arranged, and the insulated wire 32 is connected with soldering etc. in the lead 12d which inserted in the breakthrough 31 and was pulled out.

[0028]The land 33a with a breakthrough is arranged and it is connected to the other end of the right-hand side in the figure of the one turn magnetic detection coil 12b in the land 33b and through hole which were established in the opposite substrates face of this land 33a. Furthermore the land 33b has the soldering part 34, and the tip lead of the insulated wire 36 of another side in the lead 12d is connected to this soldering part 34 with soldering etc. The connection section of the one turn magnetic detection coil 12b and the lead 12d becomes stably and certain with this composition.

[0029]Next, the operation and the function in composition of this 1st example are explained. In drawing 1, the pulse Sp is sent out to the stimulus coil 10 from the magnetic stimulation pulse generator 14. The stimulus coil 10 generates the magnetic flux based on the pulse Sp inputted, and gives magnetic stimulation to the cerebrum of the subject M. This magnetic flux is detected with the one turn magnetic detection coil 12b in the pulse magnetic flux density detector 12 arranged by sticking to the stimulus coil 10. That is, the induced voltage which detected magnetic flux is generated. The detecting signal Sa which is this induced voltage is drawn through the lead 11.

[0030]Thus, the pulse magnetic flux density detector 12 is stuck to the stimulus coil 10, and when detecting the magnetic flux which the stimulus coil 10 generates, the measured region of the subject M can be easily coincided through the breakthrough 12c in the one turn magnetic detection coil 12b. By coinciding the intersection of the cross-joint wire 10a of the stimulus coil 10, and the breakthrough 12c in the one turn magnetic detection coil 12b, the stimulus coil 10 can always be arranged in a fixed position for every measurement to the one turn magnetic detection coil 12b. When estranging the stimulus coil 10 from the one turn magnetic detection coil 12b furthermore and measuring by performing magnetic stimulation, The distance of the stimulus coil 10 estranged from the center position of the one turn magnetic detection coil 12b becomes clear easily by reading the intersection of the cross-joint wire 10a in the stimulus coil 10 with the graduation of the scale 12e.

[0031]The lead 11 connected to the one turn magnetic detection coil 12b twists two insulated wires, and reduces the parasitism effective area product to magnetic flux by this. That is, the voltage induced only with the one turn magnetic detection coil 12b is drawn, and a detection error is reduced. Parallel impression of the detecting signal Sa drawn through this lead 11 is carried out at the resistor Ro. This resistor Ro carries out the shunt of the outgoing end of the pulse magnetic flux density detector 12, and the floating capacitance between the stimulus coil 10 and the one turn magnetic detection coil 12b is reduced. A noise stops mixing in the integrated voltage V1 and the partial pressure voltage V2, without overlapping the pulse Sp etc. by which the stimulus coil 10 and the one turn magnetic detection coil 12b stop joining together with floating capacitance, and are impressed to the stimulus coil 10 by this. therefore, S/N at the time of observing the integrated voltage V1 and the partial pressure voltage V2 with a monitor scope (a signal/noise) —a ratio improves and more exact measurement is attained. The value of

the resistor R_o in this case is set as larger resistance than the conductor resistance value of the one turn magnetic detection coil 12b, and resistance smaller than the resistor R_i in the integrator 16.

[0032]The pulse form detecting signal S_a is inputted into the integrator 16 through this resistor R_o , and the integrator 16 outputs the integrated voltage V_1 for observing with the monitor scope which does not illustrate the magnetic flux density B which carried out time quadrature of the detecting signal S_a to the resistor R_i with the value of the capacitor C_i . The density of the magnetic flux which the stimulus coil 10 to which the pulse S_p is impressed generates is three-dimensional distribution which has maximum magnetic flux density in a hysteresis loop near an inside diameter. It will be equalized if this magnetic flux is detected with the one turn magnetic detection coil 12b of the limited effective area product in the pulse magnetic flux density detector 12. In this case, total of the magnetic flux density which pierces through the effective area product of the one turn magnetic detection coil 12b in flux density distribution is calculated, division of this is done by the effective area product of the one turn magnetic detection coil 12b, and it is considered as the magnetic flux density measured in the center position on which the one turn magnetic detection coil 12b was put.

[0033]The voltage e induced when the magnetic flux density B interlinks to the one turn magnetic detection coil 12b of the effective area product S is expressed with a following formula (1).

$$e = -d(B \cdot S) / dt \quad (1)$$

[0034]The magnetic flux density B which carried out time quadrature of this voltage e is expressed with a following formula (2).

[Equation 1]

$$B = - (1 / S) \int e dt$$

[0035]When this time quadrature is performed by damping time constant $C_i \cdot R_i$ (the resistor R_i and the capacitor C_i in the integrator 16 in drawing 1), the integrated voltage V_1 which is an output of the integrator 16 can be expressed with a following formula (3).

[Equation 2]

$$V_1 \propto (1 / C_i \cdot R_i) \int e dt$$

[0036]The magnetic flux density B is expressed with a following formula (4) by the integrated voltage V_1 from a formula (2) and a formula (3).

[Equation 3]

$$B \propto - (C_i \cdot R_i / S) V_1$$

[0037]The integrated voltage V_1 is observed and measured with the monitor scope which is not illustrated. For example, the time-axis of a monitor scope is made into 0.5 second/Div, and it processes by delay of 2D iv. Sensitivity is set as 5 mv/Div from 500microv/Div, and 0.05 Hz -10 kHz are suitable for a filter.

[0038]The attenuator 18 carries out the partial pressure of the detecting signal S_a supplied through the lead 11 from the pulse magnetic flux density detector 12 by the resistor R_1 and R_2 , and observes it with the monitor scope which does not illustrate the partial pressure voltage V_2 . This is for knowing change of this magnetic flux ϕ in order for an eddy current to occur in the conductive substance which is an inside of a living body by the magnetic flux ϕ generated from the stimulus coil 10, and for this eddy current to stimulate a nerve and to conduct it to a living body's every direction.

[0039]This partial pressure voltage V_2 is expressed with a following formula (5).

$$V_2 = k (d \phi / dt) \quad (5)$$

[0040]This partial pressure voltage V_2 as well as the integrated voltage V_1 is observed with a monitor scope. Thus, the amount of magnetic stimulation from the integrated voltage V_1 to the cerebrum of the subject M will become clear. Change of the magnetic flux from the partial pressure voltage V_2 to the cerebrum of the subject M also becomes clear.

[0041]The evoked potential in the ulnar nerve or nervus medianus of a palm at the time of carrying out magnetic stimulation of the cerebrum of the subject M with the stimulus coil 10 is

detected by the electrodes 20a and 20b. The evoked potential by the magnetic stimulation from these electrodes 20a and 20b is measured with idiomatic evoked potential test equipment. This measurement is the same inspection method as well-known AEP (auditory evoked potential), SEP (somatic evoked potential), VEP (visual evoked response), etc.

[0042]Next, the 2nd example is described. Drawing 4 is a plan showing the composition of the pulse magnetic flux density detector in the 2nd example. In drawing 4, this pulse magnetic flux density detector 40. The one turn magnetic detection coil 40b which detects the magnetic flux which carried out the etching process of the copper foil to the substrates 40a, such as glass epoxy material, formed it in them, and was generated with the stimulus coil 10. It is provided in the substrate 40a of the center in the one turn magnetic detection coil 40b, and has the breakthrough 40c for specifying the position of the measured region of the subject.

[0043]In order to form this pulse magnetic flux density detector 40 in the inside of the one turn magnetic detection coil 40b, and the circumference of the breakthrough 40c and to try to look in at the measured region of the subject. Or the four windows 41a, 41b, 41c, and 41d for a suitable stimulus to be attained without checking generating of an eddy current when magnetic stimulation is performed in a volume conductor etc., In order to be connected to the both ends of the one turn magnetic detection coil 40b, to reduce the parasitism effective area product to the magnetic flux from the stimulus coil 10 and to prevent the magnetic flux detection of those other than one turn magnetic detection coil 40b, It has the lead 42 which twisted two insulated wires, and the electrode holder 43 which covered the projecting site of the substrate 40a with integral moulding of resin, or a vinyl cap in order to hold the fixed state of the lead 42. It is in this composition and the connection between the both ends of the one turn magnetic detection coil 40b and the lead 42 is the same as that of the connection structure shown by drawing 3.

[0044]Although operation of this pulse magnetic flux density detector 40 is the same as that of the pulse magnetic flux density detector 12 shown in drawing 2, when it performs magnetic stimulation from the windows 41a-41d, it has seen the site of the stimulus of the subject. The part at the time of this performing magnetic stimulation, the conduction direction of the nerve to give magnetic flux, for example, etc. become clear correctly.

[0045]Furthermore, the 3rd example is described. Drawing 5 is a plan showing the composition of the pulse magnetic flux density detector 50 in the 3rd example. This pulse magnetic flux density detector 50 carries out the etching process of the copper foil to the oblong substrates 50a, such as glass epoxy material, and forms it in them, The four one turn magnetic detection coils 51a, 52a, 53a, and 54a which detected the magnetic flux generated with the stimulus coil 10, and have been arranged on a straight line. It is provided in the substrate 50a in each center section of the one turn magnetic detection coils 51a-54a, and has the breakthroughs 51b, 52b, 53b, and 54b for specifying the position of the measured region of the subject.

[0046]To this pulse magnetic flux density detector 50. In order to reduce the parasitism effective area product to the magnetic flux from the stimulus coil 10 connected to each both ends of the one turn magnetic detection coils 51a-54a and to prevent the magnetic flux detection of those other than the one turn magnetic detection coil 51a - 54a. It has the leads 51c, 52c, 53c, and 54c which twisted two insulated wires, and the electrode holder 55 which covered the projecting site of the substrate 50a with integral moulding of resin, or a vinyl cap in order to hold the fixed state of these leads 51c-54c. It is in this composition and each both ends of the one turn magnetic detection coils 51a-54a and the connection with the leads 51c-54c are the same as that of the connection structure shown by drawing 3.

[0047]This pulse magnetic flux density detector 50 is the four one turn magnetic detection coils 51a-54a arranged on a straight line, and becomes measurable with one detector about four measured regions in the subject. For example, although magnetic stimulation of many parts will be carried out and they will be measured by the subject in the pulse magnetic flux density detector 40 shown in the pulse magnetic flux density detector 12 or drawing 4 shown in drawing 2, which has arranged one WATTAN magnetic detection coil, shifting the position, In this pulse magnetic flux density detector 50, since the magnetic flux density and field intensity of the magnetic stimulation pulse of four nearby parts can be measured at once, measuring time can be shortened.

[0048] Furthermore, the 4th example is described. Drawing 6 is a plan showing the composition of the pulse magnetic flux density detector in the 4th example. In drawing 6, the two turn magnetic detection coil is used for this pulse magnetic flux density detector 60 to the case where the pulse magnetic flux density detectors 12, 40, and 50 use the one turn magnetic detection coil for detection of magnetic flux, respectively.

[0049] The one turn magnetic detection coils 63a and 63b which detect the magnetic flux which this example counteracted the identical parts of both sides of the substrates 62a, such as glass epoxy material, carried out the etching process of the copper foil, formed it, and was generated with the stimulus coil 10. It is provided in the substrate 62a of the center in these one turn magnetic detection coils 63a and 63b, and has the breakthrough 64 for specifying the position of the measured region of the subject.

[0050] This pulse magnetic flux density detector 60 has the terminal area which connected the lead 65 which connects spirally the one turn magnetic detection coils 63a and 63b, and forms a two turn magnetic detection coil, and twisted two insulated wires. The breakthrough 66 of quadrangular shape by which this terminal area was provided among the both ends of the one turn magnetic detection coils 63a and 63b, This breakthrough 66 is inserted in and it has the jumper line 67 for forming the two turn magnetic detection coil which connected one end of the right-hand side in the figure of the one turn magnetic detection coil 63a, and the other end of the left-hand side in the figure of the one turn magnetic detection coil 63b, and was connected spirally.

[0051] A left-hand side end and the tip lead of one insulated wire 65a of the lead 65 are connected, [in / in this terminal area / the figure of the one turn magnetic detection coil 63a] The tip lead of the insulated wire 65b of another side of the lead 65 is inserted in in the breakthrough 66, and is connected with the other end of the right-hand side in the figure of the one turn magnetic detection coil 63b.

[0052] This pulse magnetic flux density detector 60 connects the one turn magnetic detection coils 63a and 63b with the jumper line 67, and forms them in a two turn magnetic detection coil. And the induced voltage by the magnetism generated with the stimulus coil 10 is drawn as a detecting signal with this two turn magnetic detection coil. In this case, since high induced voltage is obtained, a S/N ratio improves and the magnetic flux density and field intensity of a high-precision magnetic stimulation pulse can be measured.

[0053] If constituted in the pulse magnetic flux density detectors 12, 40, and 50 with the application of the pulse magnetic flux density detector 60 of the two turn magnetic detection coil shown in this drawing 6, It combines with each advantage, high induced voltage is obtained, a S/N ratio improves more, and measurement with the magnetic flux density and field intensity of a still highly precise magnetic stimulation pulse is attained.

[0054]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a lineblock diagram showing the 1st whole example in the magnetic stimulation sensing device of this invention.

[Drawing 2]It is a plan showing the detailed composition of the pulse magnetic flux density detector in drawing 1.

[Drawing 3]It is a plan showing the connected state of the one turn magnetic detection coil in the pulse magnetic flux density detector shown in drawing 2, and a lead.

[Drawing 4]It is a plan showing the composition of the pulse magnetic flux density detector in the 2nd example.

[Drawing 5]It is a plan showing the composition of the pulse magnetic flux density detector in the 3rd example.

[Drawing 6]It is a plan showing the composition of the pulse magnetic flux density detector in the 4th example.

[Description of Notations]

10 Stimulus coil

10a Cross-joint wire

11 Lead

12 Pulse magnetic flux density detector

12b One turn magnetic detection coil

12c Breakthrough

12d lead

12e Scale

14 Magnetic stimulation pulse generator

16 Integrator

18 Attenuator

[Translation done.]

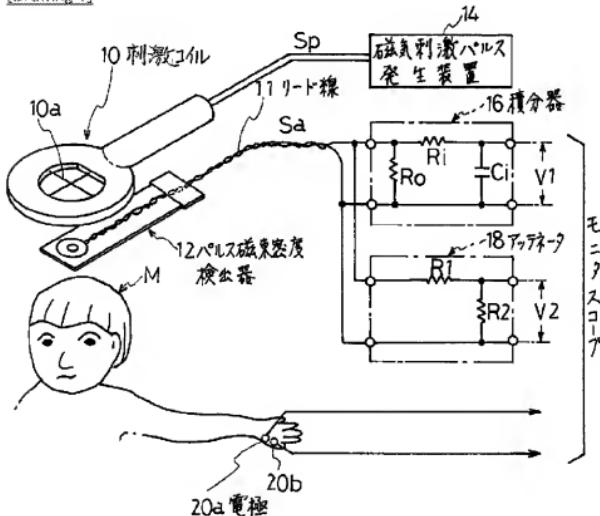
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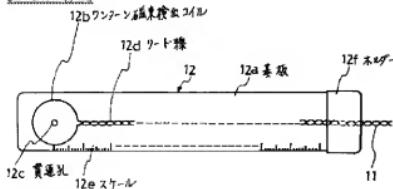
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DRAWINGS

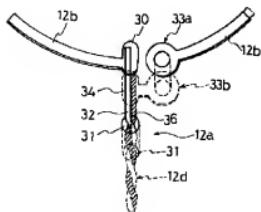
[Drawing 1]



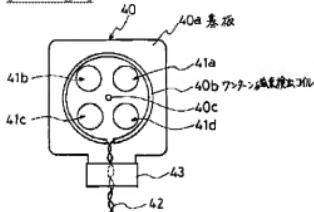
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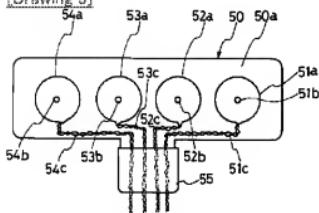
[Drawing 3]



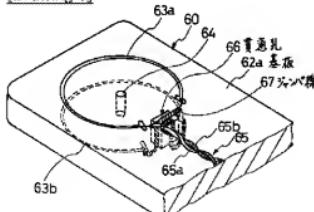
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

